

In re TURNER ET AL., Application No. 09/705,395
Amendment C

Amendments to the Claims:

The listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claim 1 (currently amended): A method for pacing the flow of information from a device, the method comprising:

inserting an entry into one of a plurality of timing wheels;

removing the entry from said one of the plurality of timing wheels at an appropriate time corresponding to a position of the entry in the plurality of timing wheels;

placing the entry into a transmit list in response to removing the entry from said one of the plurality of timing wheels, wherein the transmit list is ~~distinct from data structures of the plurality of timing wheels identifying timing positions within the plurality of timing wheels~~ not associated with a time slot within the plurality of timing wheels and entries currently in the transmit list, if any, are not currently associated with a time slot within the plurality of timing wheels, and the transmit list is configured for maintaining a plurality of entries removed from said timing wheels; and

in response to identifying the entry is the next entry to process from the transmit list: removing the entry from the transmit list, sending information corresponding to the entry, determining a next target time, and re-inserting the entry removed from the transmit list into the plurality of timing wheels based on the next target time.

Claims 2-8 (canceled)

Claim 9 (original): The method of claim 1, wherein the plurality of timing wheels include two timing wheels each having different time granularities.

Claim 10 (previously presented): The method of claim 1, wherein the next target time is determined from a last target time.

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Claim 11 (canceled)

Claim 12 (currently amended): A method for pacing the flow of a plurality of streams of information from a device, the plurality of streams including a first stream having a corresponding first pacing rate identifier and a second stream having a corresponding second pacing rate identifier, the method comprising:

maintaining a plurality of timing wheels;

inserting the first pacing rate identifier into the plurality of timing wheels at a position corresponding to a first sending time to send a packet from the first stream;

inserting the second pacing rate identifier into the plurality of timing wheels at a position corresponding to a second sending time to send a packet from the second stream;

sequencing through the plurality of timing wheels at a plurality of predetermined rates wherein at approximately the first sending time removing the first pacing rate identifier from the plurality of timing wheels and inserting the first pacing rate identifier into a transmit list, ~~with the transmit list not being distinct from data structures of the plurality of timing wheels identifying timing positions within the plurality of timing wheels associated with a time slot within the plurality of timing wheels~~, and the transmit list is configured for maintaining a plurality of identifiers removed from said timing wheels, and at approximately the second sending time removing the second pacing rate identifier from the plurality of timing wheels and inserting the second pacing rate identifier into the transmit list;

in response to identifying that the first pacing rate identifier, added to the transmit list by said inserting the first pacing rate identifier into the transmit list operation, is the next identifier to process from the transmit list: removing the first pacing rate identifier from the transmit list, sending a packet from the first stream, and re-inserting the first pacing rate identifier into the plurality of timing wheels; and

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in response to identifying that the second pacing rate identifier, added to the transmit list by said inserting the second pacing rate identifier into the transmit list operation, is the next identifier to process from the transmit list: removing the second pacing rate identifier from the transmit list, sending a packet from the second stream, and re-inserting the second pacing rate identifier into the plurality of timing wheels.

Claim 13 (original): The method of claim 12, wherein the first pacing rate identifier is inserted into the transmit list before the second pacing rate identifier, the first and second pacing rate identifiers are in the transmit list at the same time, and the second pacing rate identifier is removed from the transmit list before the first pacing rate identifier.

Claim 14 (currently amended): A method for pacing the flow of a plurality of streams of information from a device, the plurality of streams including a first stream having a corresponding first pacing rate identifier and a second stream having a corresponding second pacing rate identifier, the method comprising:

maintaining a plurality of timing wheels including a first timing wheel and a second timing wheel;

maintaining a plurality of transmit lists including a first transmit list corresponding to the first timing wheel and a second transmit list corresponding to the second timing wheel, wherein said transmit lists are ~~distinct from data structures of the plurality of timing wheels identifying timing positions within the plurality of timing wheels~~ not associated with a time slot of their respective said timing wheels, and said transmit lists are each configured for maintaining a plurality of identifiers;

inserting the first pacing rate identifier into the first timing wheel at a position corresponding to a first sending time to send a packet from the first stream;

inserting the second pacing rate identifier into the second timing wheel at a position corresponding to a second sending time to send a packet from the second stream;

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sequencing through the plurality of timing wheels at a plurality of predetermined rates wherein at approximately the first sending time removing the first pacing rate identifier from the plurality of timing wheels and inserting the first pacing rate identifier into the first transmit list, and at approximately the second sending time removing the second pacing rate identifier from the plurality of timing wheels and inserting the second pacing rate identifier into the second transmit list;

in response to identifying that the first pacing rate identifier, added to the first transmit list by said inserting the first pacing rate identifier into the first transmit list operation, is the next identifier to process from the first transmit list: removing the first pacing rate identifier from the first transmit list, sending a packet from the first stream, and re-inserting the first pacing rate identifier into the plurality of timing wheels; and

in response to identifying that the second pacing rate identifier, added to the second transmit list by said inserting the second pacing rate identifier into the second transmit list operation, is the next identifier to process from the second transmit list: removing the second pacing rate identifier from the second transmit list, sending a packet from the second stream, and re-inserting the second pacing rate identifier into the plurality of timing wheels.

Claim 15 (original): The method of claim 14, wherein the first timing wheel has a finer timing granularity than the second timing wheel, and wherein items are removed from the second transmit list only if the first transmit list is empty.

Claims 16-24 (canceled)

Claim 25 (previously presented): The method of claim 1, wherein the transmit list includes at least one other entry removed from a particular one the plurality of timing of timing wheels when said removing the entry from the transmit list is performed.

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Claim 26 (previously presented): The method of claim 1, wherein each of the plurality of timing wheels are used to schedule information of a same priority level.

Claim 27 (previously presented): The method of claim 1, comprising selecting said one of the plurality of timing wheels, prior to said inserting the entry, based on said one of the plurality of timing wheels having the finest granularity of said wheels of the plurality of timing wheels and whose range includes the target time of the entry and regardless of a rate corresponding to the entry.

Claim 28 (previously presented): The method of claim 12, wherein each of the plurality of timing wheels are used to schedule information of a same priority level.

Claim 29 (previously presented): The method of claim 14, wherein each of the plurality of timing wheels are used to schedule information of a same priority level.

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Claim 30 (currently amended): One or more computer-readable media containing computer-executable steps for pacing the flow of information from a device, said steps comprising:

- inserting an entry into one of a plurality of timing wheels;
- removing the entry from said one of the plurality of timing wheels at an appropriate time corresponding to a position of the entry in the plurality of timing wheels;
- placing the entry into a transmit list in response to removing the entry from said one of the plurality of timing wheels, wherein the transmit list is ~~distinct from data structures of the plurality of timing wheels identifying timing positions within the plurality of timing wheels~~ not associated with a time slot within the plurality of timing wheels, and the transmit list is configured for maintaining a plurality of entries removed from said timing wheels;
- in response to identifying the entry is the next entry to process from the transmit list: removing the entry from the transmit list; sending information corresponding to the entry, and determining a next target time and re-inserting the entry removed from the transmit list into the plurality of timing wheels based on the next target time.

Claim 31 (previously presented): The computer-readable media of claim 30, wherein the plurality of timing wheels include two timing wheels each having different time granularities.

Claim 32 (previously presented): The computer-readable media of claim 30, wherein the next target time is determined from a last target time.

Claim 33 (previously presented): The method of claim 30, wherein the transmit list includes at least one other entry removed from a particular one the plurality of timing of timing wheels when said removing the entry from the transmit list is performed.

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Claim 34 (previously presented): The computer-readable medium of claim 30, wherein each of the plurality of timing wheels are used to schedule information of a same priority level.

Claim 35 (previously presented): The computer-readable medium of claim 30, wherein said steps include selecting said one of the plurality of timing wheels, prior to said inserting the entry, based on said one of the plurality of timing wheels having the finest granularity of said wheels of the plurality of timing wheels and whose range includes the target time of the entry and regardless of a rate corresponding to the entry.

Claim 36 (currently amended): An apparatus for pacing the flow of information from a device, said apparatus comprising:

means for inserting an entry into one of a plurality of timing wheels;

means for removing the entry from said one of the plurality of timing wheels at an appropriate time corresponding to a position of the entry in the plurality of timing wheels;

means for placing the entry into a transmit list in response to removing the entry from said one of the plurality of timing wheels, wherein the transmit list is ~~distinct from data structures of the plurality of timing wheels identifying timing positions within the plurality of timing wheels~~ not associated with a time slot within the plurality of timing wheels, and the transmit list is configured for maintaining a plurality of entries removed from said timing wheels;

means for in response to identifying the entry is the next entry to process from the transmit list: removing the entry from the transmit list, sending information corresponding to the entry in response to the entry being removed from the transmit list, and determining a next target time and re-inserting the entry removed from the transmit list into the plurality of timing wheels based on the next target time.

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Claim 37 (previously presented): The apparatus of claim 36, wherein the plurality of timing wheels include two timing wheels each having different time granularities.

Claim 38 (previously presented): The apparatus of claim 36, wherein the next target time is determined from a last target time.

Claim 39 (previously presented): The apparatus of claim 36, wherein the transmit list includes at least one other entry removed from a particular one the plurality of timing of timing wheels when said removing the entry from the transmit list is performed.

Claim 40 (previously presented): The apparatus of claim 36, wherein each of the plurality of timing wheels are used to schedule information of a same priority level.

Claim 41 (previously presented): The apparatus of claim 36, including means for selecting said one of the plurality of timing wheels, prior to said inserting the entry, based on said one of the plurality of timing wheels having the finest granularity of said wheels of the plurality of timing wheels and whose range includes the target time of the entry and regardless of a rate corresponding to the entry.

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Claim 42 (new): An apparatus for pacing the flow of information from a device, said apparatus comprising:

one or more timing wheels;

one or more transmit lists;

a timing wheel process configured to repeatedly advance through said timing wheels and at corresponding scheduled times and to remove entries from said timing wheels at their respective scheduled times and to add said removed entries to said transmit lists, wherein said transmit lists are not associated with a time slot within any of the plurality of timing wheels and said entries added to said transmit lists are not associated with a time slot of said timing wheels while awaiting processing by a transmit list process; and

the transmit list process configured to, when said transmit lists are not empty: remove a next particular entry from said transmit lists, send information corresponding to the next particular entry, determining a next target time for the particular entry, and causing the next particular entry removed from said transmit lists to be re-inserted into said timing wheels based on the next target time.

Claim 43 (new): The apparatus of claim 42, wherein each transmit list of said one or more transmit lists is configured to store a plurality of entries.